

BioEnergy Options & Opportunities in Arkansas

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Jim Wimberly
BioEnergy Systems LLC
Fayetteville, AR
www.biomass2.com



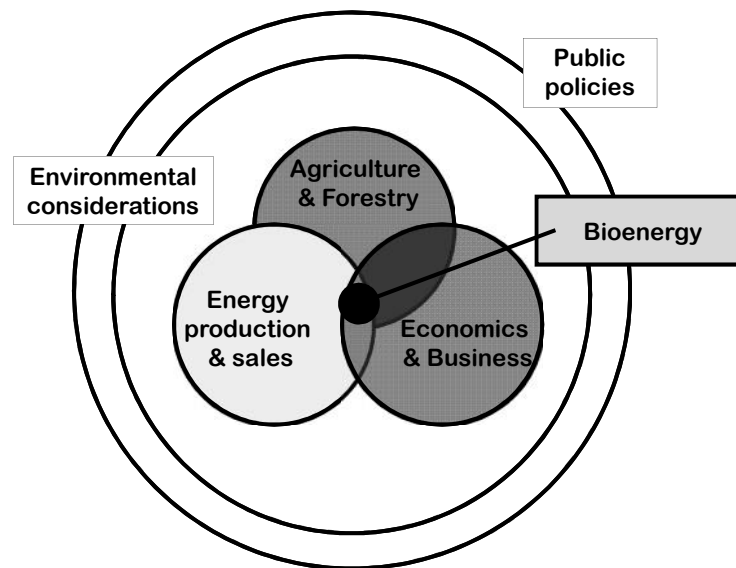
Presentation overview

- ❖ Overview of biomass energy
 - Bioenergy basics
 - Potential benefits to Arkansas
 - Key terminology
- ❖ Potential bioenergy enterprises of particular interest to Arkansas
 - Biorefineries
 - Biopower
 - Co-firing
 - CHP
 - Combined-Heat-and-Char

Bioenergy basics

- ❖ Bioenergy is a form of solar energy
 - Atmospheric carbon converted to plant mass via photosynthesis
 - Plants are essentially solar batteries
- ❖ A variety of biomass-derived products
 - Liquid transportation fuels
 - Electricity
 - Thermal energy
 - Space heating
 - Steam (process heat)
 - Intermediate energy products
 - Pellets
 - High-value non-energy co-products
 - E.g., biobased polymers for plastics manufacturing

Bioenergy is unique...



Bioenergy can be good for Arkansas

- ❖ Significant investment opportunities
 - Example: 5 commercial-scale enterprises... ~\$2 billion capital cost
- ❖ Significant potential energy contributions
 - 100's of millions of gallons of biofuels per year
 - 100's of megawatts of power
- ❖ Significant economic benefits to the State
 - 1000's of jobs
 - Feedstock production, harvesting, & transport
 - Operations of biorefineries and biopower facilities
 - Home-grown fuel
 - Reduced import of coal & refined liquid fuels from other states
 - Economic benefits to existing industries
 - Forest products
 - Agriculture

But, bioenergy is not easy...

- ❖ Numerous logistical challenges
 - Biomass feedstock supply chains are complicated
- ❖ The economics are, generally, not attractive...
 - Biofuels cannot currently compete with petro-derived fuels
 - Without support programs such as the RFS2
 - Biopower cannot currently compete with power from coal or NG
 - But, current conditions are expected to change
 - And we should move forward now with these energy options
 - Public policies are critical
 - and several federal support programs already exist
- ❖ In order to pursue commercial-scale deployment...
 - *We need to understand the details of bioenergy options and opportunities in order to make informed decisions about public policies that stimulate (or constrain) commercial deployment*

Under
current
economic
conditions

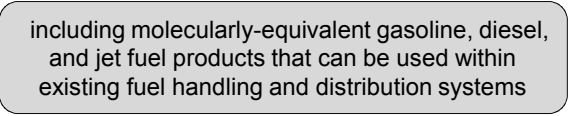
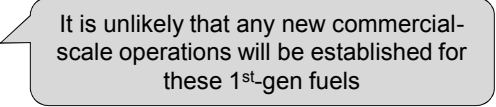
Bioenergy terminology

❖ Feedstocks

- Plant- or animal-derived material
 - converted in value-added products
- Examples
 - Woody biomass
 - √ In-forest residues (IFR)
 - Ag field residues
 - Dedicated energy crops
 - Chicken litter
- Biomass feedstock supply chain
 - All of the activities associated with delivery of biomass
 - √ Crop establishment
 - √ Production & harvesting
 - √ Storage & transportation
 - √ Pre-processing

Bioenergy terminology

❖ Biofuels

- Liquid transportation fuels made from biomass
- Examples:
 - Drop-in fuels 
 - Cellulosic ethanol
 - Renewable diesel
 - √ This is different from oil-derived biodiesel
 - First generation biofuels 
 - √ Corn-derived ethanol
 - √ Soy-derived biodiesel
- Produced at a biorefinery
- Facility size typically measured in millions of gallons per year (MGY)
 - Average cellulosic biorefinery size = 40 MGY

Bioenergy terminology

❖ Biopower

- Electricity from biomass
 - Biopower facilities are more suitable for base-load (like coal)
- Types of biopower facilities
 - Stand-alone powerplant
 - √ A dedicated biomass-to-electricity generating facility
 - Co-firing
 - √ Biomass fuel is used to displace a fraction of coal
 - CHP
 - √ “Combined heat and power”
 - √ Co-generation (“co-gen”)
 - » Thermal energy + electricity

most large forest products manufacturing facilities in Arkansas already have a CHP system

Bioenergy terminology

❖ Biopower basics

- 1 Megawatt (MW) = 1,000,000 watts
- 1 Megawatt-hour (MWh) = 1 megawatt for 1 hour
- Capacity Factor (CF) = % of the year a facility generates full power

❖ Conversion technologies

- Platforms (pathways)
 - Biochemical
 - √ Fermentation
 - √ Anaerobic digestion
 - Thermochemical
 - √ Combustion
 - √ Gasification
 - √ Pyrolysis

Areas of specific interest for Arkansas

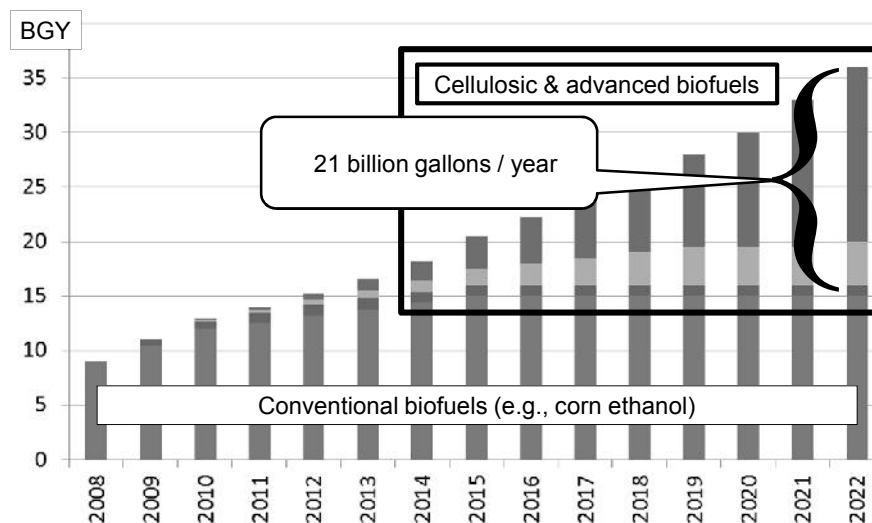


- ❖ Biorefineries
- ❖ Biopower
 - Co-firing
 - CHP
- ❖ Integrated facilities
 - Biorefinery
 - Biopower
 - Thermal energy
 - High-value bio-based non-energy products
- ❖ Combined-Heat-and-Char
 - For broiler and turkey farms

Biorefineries

- ❖ The primary driving factor: RFS2

RFS2 = Renewable Fuels
Standard (version 2)
(established 1997, revised 2010)

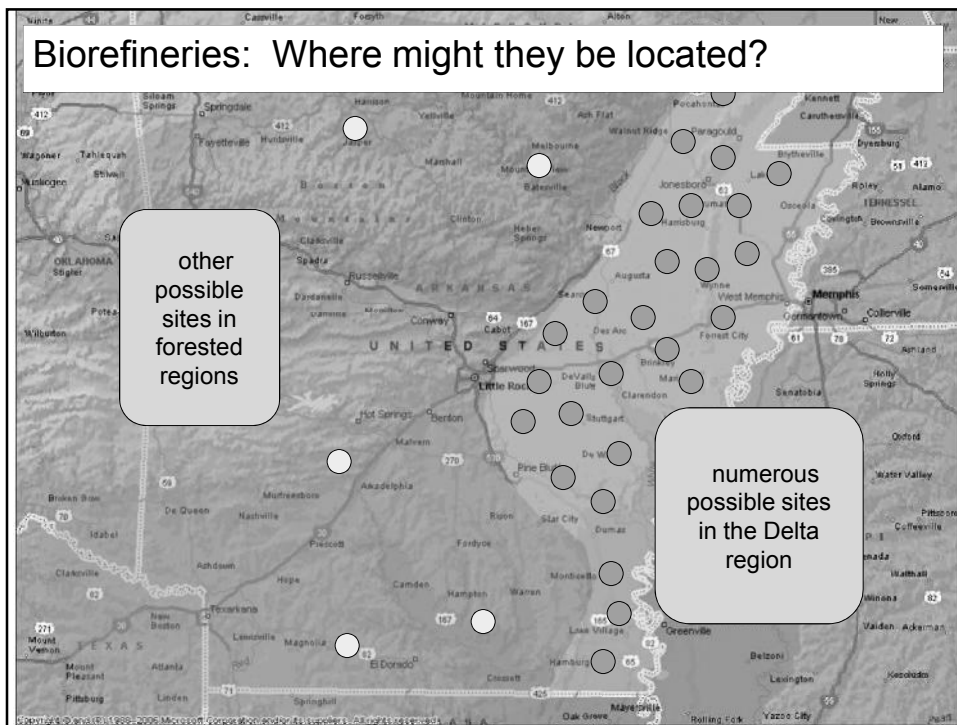


Biorefineries

assuming at least half will be established as expanded operations of existing corn-ethanol facilities located in the mid-west (using corn stover as the cellulosic feedstock)

- ❖ 21 BGY ... that's at least 200 new biorefineries
 - That's an average of 4 per state
 - But, given Arkansas' resource base, we should be above average
 - So, how many should we plan for?
- ❖ One biorefinery...
 - Imagine a hybrid paper mill and small oil refinery
 - Biomass feedstocks needed
 - ~500,000 dry tons / year
 - On average, ~2/3rds will come from dedicated energy crops
 - √ The balance from woody/ag residues
 - Capital cost: ~\$270,000,000
 - Revenues from product sales: ~\$120,000,000 per year
 - Jobs created: ~960 (direct) for 30 years

Biorefineries: Where might they be located?



Biorefineries...how might we pursue for AR?

- ❖ We're competing with every neighboring state
 - Biorefineries have been initiated in MO, TN, MS, LA, TX, OK, & KS
- ❖ Project developers seek to reduce project risks
 - They need to reduce uncertainties re feedstock supply chains
 - AR needs an updated biomass resource assessment
 - The research community needs help addressing key issues
 - They cannot move forward with project financing
 - How can we help them secure project financing?
 - They need to know who to contact within the State
 - More coordination between state agencies and private sector
- ❖ A new report from Winrock will shed more light on the economics of a hypothetical biorefinery in northeast AR
 - Due out by early March

Biopower

- ❖ Types of biopower facilities
 - Stand-alone powerplant
 - A dedicated biomass-to-electricity generating facility
 - Co-firing
 - Biomass fuel is used to displace a fraction of coal
 - Maintain same capacity and power generation
 - CHP
 - "Combined heat and power"
 - Co-generation ("co-gen")
 - √ Thermal energy + electricity

let's have a
closer look at
co-firing

We can also envision
integrated biorefineries,
including CHP

Co-firing

- ❖ There are currently 4 coal-fired powerplants in Arkansas...
 - Total installed capacity = 4,600 MW
 - Typical capacity factor (CF) = 83%
 - $4,600 \text{ MW} \times 8760 \text{ hours/year} \times 83\% = 33,500,000 \text{ MWh/yr}$
 - ~ 1,200 train loads of coal per year
- ❖ Let's look at a 2% biomass co-firing rate at all 4 facilities...
 - Equates to ~100 MW of biopower
 - Requiring ~750,000 tons/year of biomass
 - Displace ~25 train-loads per year with home-grown fuel
 - Value of home-grown fuel: ~\$35,000,000
 - Job creation: ~200 (direct) for 30 years

But we need details re co-firing options

- ❖ Co-firing capabilities are specific to each site
 - The ability to co-fire will vary from one powerplant to another
- ❖ An assessment is needed for each of the 4 sites
 - Evaluate the technical options
 - What co-firing levels could that particular boiler accommodate?
 - What are the on-site logistics & other technical considerations?
 - Evaluate the potential feedstock supplies
 - What types of feedstocks would be available for that site?
 - How might a feedstock supply chain be established for that site?
 - Evaluate the potential economics
 - Capital costs
 - Operating costs
 - Potential rate impacts (at various target co-firing levels)
 - Determine potential job creation

Co-firing...how might we pursue for AR?

- ❖ Undertake assessments to determine co-firing options
- ❖ Coordinate between the key parties, e.g.:
 - At the state level: AAEC, AEDC, APSC, ADEQ
 - With the various utilities that own/operate the generating facilities
- ❖ Consider a pilot renewable power program
 - RPS = Renewable Portfolio Standard
 - A state-level program requiring a fixed % of all electricity to be generated from renewables
 - 33 states already have some type of RPS in place and several others are considering an RPS or a pilot program approach
 - Look at what has recently been done in LA and other nearby states

Combined-heat-and-char

- ❖ Use chicken litter as fuel
 - Generate thermal energy to displace propane for space heating
 - Also produce biochar, a valuable byproduct
 - Farm-based renewable energy systems
 - After 20 years of R&D, the technology is now available
- ❖ Multiple benefits
 - Economic benefits to broiler producers
 - Economic benefits from Arkansas-based manufacturing
 - Water quality benefits (from avoided land application of litter)
 - Displacement of fossil fuels with renewable biomass
- ❖ What's needed to move this forward?
 - Support for a full-scale on-farm test & demonstration
 - Support (to UA) for evaluations of using biochar
 - Essential for development of biochar markets

In summary

- ❖ There are several commercial-scale bioenergy opportunities
 - Biorefineries – particularly for drop-in fuels
 - Biopower via co-firing
 - Integrated biorefinery and CHP operation
 - Combined-heat-and-char
- ❖ Actions needed
 - Expanded efforts to attract bioenergy projects
 - Including a pilot RPS program
 - Including an updated statewide feedstock assessment
 - Assessments of co-firing potential at AR's 4 coal-fired powerplants
 - Support for farm-scale litter-to-heat-and-char systems

Jim Wimberly
BioEnergy Systems LLC
Fayetteville, AR
wimberly@biomass2.com
www.biomass2.com
501.527.0478

